

Chapter 3: Adapting to Change



Climate change is projected to have significant impacts on important economic, health, and natural resource sectors throughout New Hampshire in the 21st century. New Hampshire must continue to plan for these impacts even as it works to address its causes. Carbon dioxide (CO₂), the main driver of climate change, has an atmospheric residence time ranging from decades to hundreds of years and will remain in the atmosphere for, on average, 100 years once released. There is also a delay in the climate's response to increasing atmospheric concentrations of greenhouse gases due to the scale of the interdependent physical, chemical, and biological processes that compose the global climate system in the ocean and atmosphere and on land. Therefore, climate change is expected to continue for some time even if all man-made greenhouse gas emissions were reduced significantly in the near future.

Because New Hampshire's climate is already changing, and will continue to change over the next several decades, some level of climate change adaptation is necessary to ensure that

the current and future impacts of climate change do not significantly impact the health of our residents, the strength of our economy, and the character of our natural environment. Adaptation actions and responses should be evaluated and where necessary, implemented, in order to couple actions to reduce carbon emissions with adaptation. By preparing for climate change early, the state can avoid significant costs, whether economic, social or ecological, in the future.

PURPOSE OF CLIMATE CHANGE ADAPTATION

Climate change adaptation is defined as action taken to avoid or minimize the negative impact of, or take advantage of, new opportunities created by a changing and increasingly variable climate. By contrast, actions to reduce greenhouse gas emissions (i.e., mitigation) avoid or minimize climate change by limiting the accumulation of atmospheric greenhouse gases.

Adaptation actions fall into several categories. Some actions may *increase natural resilience* in species, ecosystems, and

communities to facilitate recovery from climate disturbances or adjust to new patterns of climate variability and climate extremes¹. Other actions may also entail proactive steps to *facilitate responses* to climate change that help human communities and ecosystems persist under new conditions in place or elsewhere². Finally, other adaptation actions could *build resistance* to climate change by helping human communities and ecosystems resist impacts and maintain valued resources³. In some cases, the best approach may be to employ multiple actions simultaneously.

ECONOMIC IMPACTS OF CLIMATE CHANGE

Anthropogenic climate change is already underway and is projected to continue to impact New Hampshire's human health, man-made infrastructure, coastal settlements, and agricultural, forest and water resources⁴. These impacts are already affecting the state's economy⁵ and without efforts to adapt, these impacts are anticipated to have a more significant influence on our economy in the future⁶. Globally, the cost of inaction has been estimated to be the equivalent to losing at least 5 percent of global gross domestic product each year, now and into the future⁷.

Adopting a "wait-and-see" approach to climate change adaptation is anticipated to be more costly than taking early adaptation actions that anticipate and prepare for specific types of climate disruption. The damage caused by Hurricane Katrina illustrates the vulnerability of long-lived assets and infrastructure (e.g. dams, bridges, coastal and floodplain development) to the types of extreme weather events that are projected to occur by climate change models. A "wait-and-see" approach would be especially inadequate in responding to:

- Irreversible impacts, such as species extinction or uncoverable ecosystem changes.
- Unacceptably high costs and damages that could result from inappropriate development in the coastal zone or 100-year floodplain that could expose lives and property to intense storms and flooding.
- Damage to long-lived investments and infrastructure (e.g., bridges, water and wastewater treatment facilities) that may be costly (or prohibitive) and time-consuming to repair or replace following intense storms.

To plan for the potential impacts from a changing climate, society requires updated and decision relevant information

combined with mechanisms to educate and engage decision makers and the public. Without accurate information, appropriate decision-making can be more challenging. We could begin this process by:

- Investing in the assessment of existing sources of information, updating information and identifying gaps; actions that could include the development of updated coastal and freshwater 100-year floodplain maps, which reflect current conditions and potential future flooding under different climate change scenarios, LIDAR mapping of coastal and estuarine systems, built infrastructure risks.
- Disseminating reliable and decision-relevant information about the economic, environmental, and social impacts of climate change to decision makers and the general public.

See: *Invest in the Development and Distribution of Critical and Decision Relevant Information (ADP Action 1)*. Discussed in detail in Chapter 5 and Appendix 4.9.

At the state and local level, we need to create policies to support economic development that accounts for the chang-

Winter Storm Response

New Hampshire's current response to winter storm events could provide a model for coordinating state-wide efforts to extreme weather events (e.g., flooding, hurricanes) that are projected to increase in the future. The development of more extensive projections of extreme weather (e.g., frequency, magnitude) can be provided to decision-makers to facilitate integrated planning and coordination of event response by state and local entities. This development would include the communication channels over which event forecasts could be disseminated to state and local authorities and to the public to enhance preparation in advance of storms.

ing climate and attracts climate friendly employers. This would include developing new technologies for adapting to climate change and fostering new opportunities in adaptive technologies and services. Implementation may require the development of infrastructure to support businesses adapting their business model to climate change. We can do this by:

- Anticipating the effects of climate change on current industries (e.g., skiing, agriculture, tourism, forestry and logging, etc.) and assisting in stabilizing and enhancing their income.

- Developing “green collar” training and education programs.
- Attracting alternative energy and other “clean-tech” industries.
- Taking advantage of any new economic opportunities where New Hampshire might create a niche for itself in sustainable economic development.

See: *Strengthen the NH Economy for Adaptability to Climate Change (ADP Action 6)*. Discussed in detail in Chapter 5 and Appendix 4.9.

HUMAN HEALTH IMPACTS OF CLIMATE CHANGE

Challenges currently faced by at-risk populations are projected to increase in any climate change scenario. As a state we need to focus policies and actions to help the most at risk populations (e.g., elderly, low income, chronically ill, children) as well as the general population to prepare for the impacts of climate change and related social impacts. These considerations behind these preparations could include: the cost and availability of transportation; the ability to heat and cool homes; access to “cool shelters;” the availability of food and potable water; access and affordability of healthcare; and the potential need to relocate. To accomplish this we need:

- Public health and emergency response agencies to collaborate with the appropriate agencies and organizations to develop effective public outreach.
- Partnerships between these organizations to share relevant data and information.
- Education and empowerment of public health officials in New Hampshire to prepare for health related and social impacts resulting from climate change.

See: *Focus Policies and Actions to Help At Risk Populations Prepare for Impacts of Climate Change (ADP Action 2)*

Charge and Empower Public Health Officials to Prepare for the Public Health Impacts of Climate Change (ADP Action 3). Discussed in detail in Chapter 5 and Appendix 4.9.

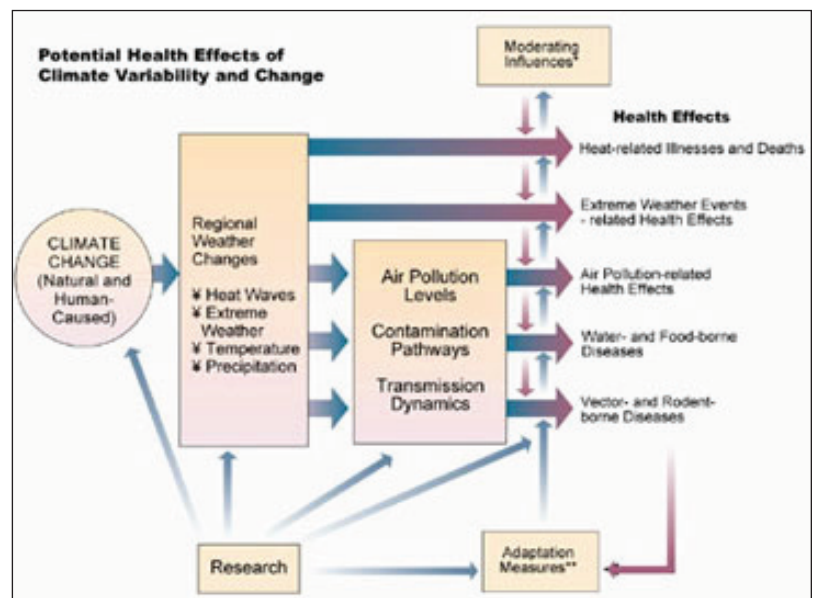
Without action, climate change could increase the incidence

of heat stress, respiratory illness, and infectious diseases (Figure 3.2). Climate change may also increase the incidence of injury and death from severe weather events. Increasing our public health capacity and working with community planners would help society prepare for the myriad health impacts for climate change and expand access to healthcare and reliable havens from heat, air pollution, air-borne allergens, and extreme weather.

Specific Health Impacts and Stressors

Thermal Stress/Heat Waves – Humans are susceptible to high temperatures and heat waves are a major public health threat. The combined death toll from the blistering heat wave in Europe in August 2003 reached over 32,000⁹. The 1995 heat wave in the Midwest led to nearly 700 heat related deaths in less than a week¹⁰. Under a higher-emissions scenario, which relies primarily on high-CO₂-emitting fossils fuels as an energy source, the Concord/Manchester area is projected to experience nearly 65 days per year when the heat index is above of 90°F¹¹. The elderly, young children, pregnant women, the

Figure 3.2 - Potential Health Effects of Climate Variability and Change⁸



chronically ill, and essential service workers are particularly vulnerable to heat stress of this nature. Heat-related risks and vulnerabilities to New Hampshire’s population can be alleviated by increasing public health capacity in the state through actions such as community partnerships and increased access to healthcare as well as modifying buildings and having early warning systems in place and functional.

Air Quality – Air quality in New Hampshire is related to weather conditions, with many of the worst air quality days occurring during hot summer days. Under high-emissions scenarios, the Concord/Manchester area could experience a quadrupling of poor air quality days above present levels (from 4 to 16) as defined by the EPA. Air quality is a significant health concern, especially for sensitive populations such as children, the elderly, and people with respiratory disease. Decreased air quality has been linked to the onset of asthma, and to increased frequency of asthma symptoms. In addition, increased temperatures and CO₂ levels would lead to increased pollen production in several key allergenic species such as ragweed¹².

Infectious Diseases – An increase in hot weather would likely facilitate the spread of vector-borne infectious diseases such as Lyme disease, eastern equine encephalitis and West Nile virus. Intense public health monitoring programs have already been implemented for vector-borne disease. The role of climate change in the spread and incidence of other infectious diseases is poorly understood. In general, many of these diseases can be effectively avoided with prevention and control programs and adequate financial and public health resources, including training, surveillance, and emergency response.

Storms and Flooding – More frequent and extreme weather events projected by climate change models would damage property and threaten public safety. The settlement pattern in New Hampshire has taken place largely around rivers and lakes with floodplain areas often being the easiest areas to develop. Floodplains, however, are where the most flood losses occur. Development in these areas puts people, buildings and infrastructure in harms way, and increases the rate and amount of floodwater forced downstream causing more damage¹³. Flooding would also diminish public health by spreading toxins, contaminating water supplies, disabling local septic systems, wastewater treatment systems and combined sewer overflows, in addition to damaging roads and buildings.

NATURAL SYSTEMS IMPACTS OF CLIMATE CHANGE

Agriculture and Forestry

From July 2001 through June 2002, New Hampshire's agriculture industry generated \$930 million in direct spending, representing over 2 percent of the state GDP, and supported almost 12,000 jobs¹⁴. In addition, the state's forests provide a wealth of ecosystem services that include recreation, tourism,

wildlife habitat, timber and other forest products, protection of watersheds and drinking water supplies, carbon storage, nutrient cycling and soil conservation¹⁵. As a result, forests are a critical part of the New Hampshire economy. In 2005, forest-based manufacturing and forest-related recreation and tourism in the state contributed over \$2.3 billion¹⁶. These industries will face significant challenges as the climate continues to change. Climate models project decreases in the number of frost days, where temperatures dip below freezing, and increases in the length of the frost-free growing seasons. Tree species composition is likely to change¹⁷. Warmer winter temperatures would also allow for the northward migration of the hemlock woolly adelgid that has decimated hemlock forests to the South¹⁸. The eventual changes in forest composition and function could profoundly alter the scenery and character of New Hampshire, as well as the ecosystem services our forests provide.

The Northeast's agricultural economy is dominated by dairy and high-value horticultural crops. Over the course of the century, rising temperatures and erratic weather conditions generated by climate change could threaten the productivity and economic viability of some crops and livestock that have been important historically but that are adapted to a cooler climate¹⁹. Some of the agricultural issues we face include changes in growing season and crop productivity, summer heat stress, increased rainfall and drought, and greater growth in weeds and insect pests²⁰.

Sustaining New Hampshire's agricultural and forest industries require evaluating strategies that:

- Alter the timing of planting dates in response to changing growing conditions.
- Maintain local agricultural lands.
- Alter crop mix and forest species to better match the changing climatic conditions.
- Breed new plant species and crops more tolerant of changed climate condition.
- Promote fire suppression practices in response to increased fire risk.
- Adopt forestry practices that enhance carbon storage.
- Maintain forest reserves for species and genetic diversity.

Coastal Areas and Sea-Level Rise

Relative sea level rose at an average rate of 2.0-2.7 mm per year over the last century in New Hampshire, nearly a foot per

century²¹. Sea-level rise is likely to accelerate in the future. The United Nations Intergovernmental Panel on Climate Change (IPCC) projects that, based primarily on increases in water volume due to increases in sea surface temperatures, global sea level is projected to rise into the twenty first century. It is projected that sea levels will rise between 7 and 14 inches if greenhouse gas emissions are reduced significantly and between 10 and 23 inches if greenhouse gas emissions continue to increase at their present rate. A recent study suggests that if current rates of ice discharge from the Greenland and West Antarctic ice sheets are taken into account, sea levels could rise as much as 2.6 to 6.6 feet (31 to 79 inches) by 2100²².

Protecting New Hampshire's coastal areas requires actions that:

- Analyze the environmental consequences of shore protection.
- Promote shore protection techniques that protect habitat.
- Identify land use measures to ensure that wetlands migrate inland as sea level rises in some areas.
- Engage state and local governments in defining responses to sea-level rise.
- Educate decision-makers about the importance of changing zoning regulations.

Ecosystems and Wildlife

There are many significant implications of climate change for New Hampshire's ecosystems and wildlife populations. Many species are already stressed by land-use change, pollution, invasive species, and habitat fragmentation. These non-climatic stressors interact synergistically with climate stressors and result in greater overall impacts²³. For example, when brook trout are exposed to pesticides, their nervous and reproductive systems can be affected. Those impacts increase as water temperature rises. Warmer water also reduces the amount of oxygen available to fish and can also result in less offspring being produced. The combined impact of climate change and existing environmental stressors therefore can compromise species' resilience and their opportunity for successful adaptation to climate change^{24, 25}.

The key to ensuring ecosystem and wildlife adaptation is to maintain overall ecosystem health and to conserve important areas. An intact ecosystem is a more resilient ecosystem, capable of recovering from perturbation (e.g., storms, heat waves). Multiple examples of each habitat type must be protected to

guard against the risk that some sites may be irretrievably altered in the future.

In addition, effective conservation in the face of a rapidly changing climate requires consideration of the current location of plants, animals and natural communities as well as where they might be located in the future. Presently, fragmentation of natural systems by roads, infrastructure and other alterations has created obstacles to potential migration. Adaptation may require the addition of corridors between protected areas or stepping stones of reserve networks across gradients to ensure that species can continue to move toward their optimal climatic zones in all directions.

Protecting New Hampshire's ecosystems and wildlife requires evaluating strategies that:

- Encourage development and growth in existing urban areas while avoiding natural areas.
- Develop a system of intact protected natural areas to foster resiliency, to allow for species movement and also to protect ground water.

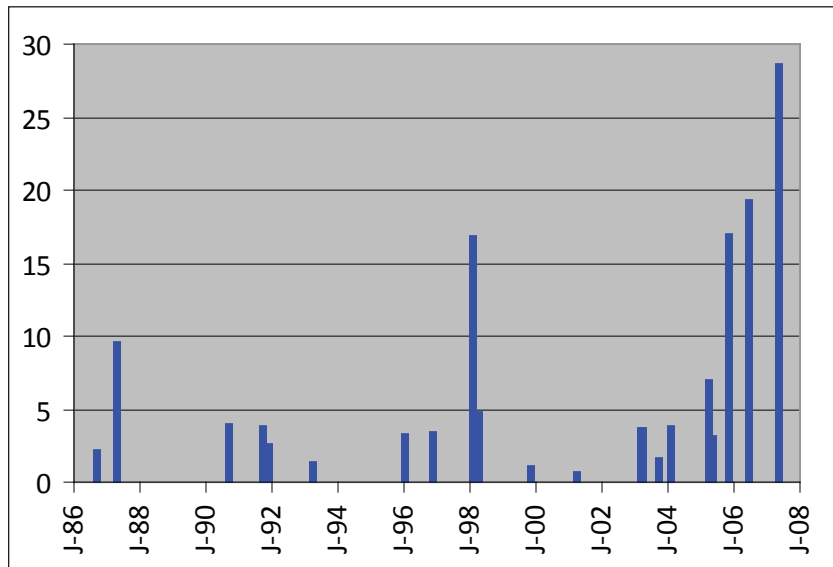
See: *Strengthen the Protection of New Hampshire's Natural Systems (ADP Action 4)*. Discussed in detail in Chapter 5 and Appendix 4.9.

INFRASTRUCTURE IMPACTS OF CLIMATE CHANGE

New Hampshire's critical infrastructure includes roads, buildings, drinking-water treatment and distribution systems, wastewater systems, communications systems, and electricity distribution networks. Storm-related damage poses the greatest threat to the state's infrastructure and can significantly disrupt daily life, affect the state's economy, and threaten the health and safety of New Hampshire residents.

Since 1986, New Hampshire has spent \$138 million in total repairing the damages due to severe storms and flooding associated with Presidentially Declared Disasters (Figure 3.4)²⁶. Over this time, severe storms increased in frequency and severity, causing more damage and leading to higher recovery costs for the state. The state incurred more than half of these costs, \$87 million, in the last seven years. Riverine flooding is the most common disaster event in the State of New Hampshire²⁷. Over the past three years, New Hampshire has experienced three 100-year flood events; with one event costing the state \$35 million²⁸.

Figure 3.4 – Costs Related to Presidentially Declared Disasters in New Hampshire Individual Storm Event Damage (Cost in Millions of Dollars)



Projections of future impacts from climate change include increases in overall precipitation, an increase in extreme precipitation events, and more flooding. New Hampshire’s municipal water and wastewater utilities are largely unprepared for increased flood frequency and volume. Even modest disruptions can have significant impacts on daily life. Potential disruptions include alteration to the hydrological regime resulting in pressure on wastewater and stormwater systems in their ability to handle large volumes of water in short time.

Protecting New Hampshire’s infrastructure requires evaluating strategies that:

- Create a policy for coastal and floodplain properties that plans for residents and structures needing to relocate due to flooding or inundation.
- Guide future development away from flood prone areas and maintain adequate setbacks.
- Render the existing environment more resilient to weather related impacts.

- Utilize municipal ordinances, building codes, zoning regulations, land use practices, infrastructure planning, and incentives to protect against risks.

See: *Increase Resilience to Extreme Weather Events (ADP Action 5)*. Discussed in detail in Chapter 5 and Appendix 4.9.

UNDERSTANDING THE RISKS OF CLIMATE CHANGE

Adaptation planning involves many uncertainties. State and local government must establish transparent climate change adaptation planning procedures that are fully integrated with other aspects of their work. They must ensure that their short-term and long-term commitments allow for and

encourage adaptive management in an effort to establish a “no regrets” strategy for New Hampshire to adapt to climate change. By preparing for climate change early, the state can avoid significant costs, whether economic, social or ecological, in the future.

Climate change poses a threat to all aspects of New Hampshire. Going forward the state will need to better understand the risks and vulnerabilities that the human and natural communities face as projections of climate change impacts become more refined and detailed. The state will need to plan for these impacts with the best understanding of the resources that are available to address the issue at the state, regional and national level. This would require more comprehensive and integrated planning with a variety of stakeholders and should begin immediately and continue into the future.

See: *Develop a Climate Change Adaptation Plan for New Hampshire (ADP Action 8)*. Discussed in detail in Chapter 5 and Appendix 4.9.